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Staged Carotid Stenting and Carotid Endarterectomy for Bilateral Internal Carotid Artery Stenosis

Preliminary Experience

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Summary

The purpose of this study was to evaluate the efficacy and safety of staged carotid stenting (CS) and carotid endarterectomy (CEA) for bilateral internal carotid artery stenosis.

With this strategy, initial carotid stenting was performed for the high grade carotid stenosis to reduce the risk of subsequent CEA. Eight patients were treated with staged CS and CEA; CS for asymptomatic side followed by CEA for symptomatic side. Sufficient revascularization was obtained in all procedures but one CS procedure.

Two minor stroke caused by distal embolism occurred during the perioperative period of CS. Postprocedural persistent hypotension was observed in one CS procedure. The mean interval between CS and CEA was 19.8 days. In conclusion, although our strategy has some advantages such as avoidance of bilateral cranial nerve palsy and shorter admission period over staged CEA, relatively high complication rate was noted at the first CS without any stroke morbidity post CEA.

Our preliminary result showed that further reduction of periprocedural complication rate at the initial stenting is mandatory for this approach justified.

Introduction

Carotid endarterectomy (CEA) is a well-established procedure that provides documented benefits to many patients with high-grade carotid artery stenosis. It has been already proved that the prophylactic effect against stroke benefiting from CEA is significantly higher than that benefiting from the best medical therapy [1,2]. However, this dominancy was proved under the condition that perioperative morbidity and mortality rate did not exceed 6% in symptomatic cases, and 3% in asymptomatic cases.

Recently, there has been growing interest in carotid stenting (CS) to treat a selected group of patients with carotid artery stenosis who are considered as poor candidates for CEA [3]. In fact, it is reported that CS can be performed with lower perioperative complication rate than CEA in the high-risk group such as patients with contralateral carotid artery occlusions [4].

On the other hand, the treatment of bilateral carotid artery high-grade stenosis is still controversial and many options such as bilateral staged CEA, bilateral staged CS, or the combination of CEA and CS are proposed. In our institute since 1997, patients with bilateral carotid artery stenosis have been treated by staged CS and CEA. In our strategy, CS for asymptomatic side was performed first followed by CEA for symptomatic side later.

Methods

Between april 1997 and march 2000, 8 patients with bilateral carotid high-grade stenosis (≥ 70% stenosis by North American Symptomatic Carotid Endarterectomy Trial [NASCET] calculation) were treated with our staged CS and CEA strategy. In all patients but one, CS for asymptomatic side was performed first and CEA for symptomatic side was performed later. In one patient with bilateral asymptomatic carotid stenosis, CEA was applied to the side with more severe stenosis. The average age was 68 years (± 5; SD) and all patients were male. The average percent stenosis of CEA (symptomatic) side was 90.7 (± 5.9%) and that of CS (asymptomatic) side was 77.6 (± 10.4%).

Preoperatively, medical condition and initial neurological events of each patient were recorded. Preoperative workup included magnetic resonance imaging (MRI) of the brain, helical computed tomographic scan and duplex ultrasonography of cervical carotid artery, and cerebral blood flow (CBF) study using single photon emission computed tomographic scan (SPECT). The profiles of the cases were summarized at table 1. Carotid endarterectomy was performed as described before with selective shunting under sensory evoked potential (SEP) monitoring.

Carotid Stenting Protocol:

All patients took antiplatelet agent such as aspirin or ticlopidine starting at least 7 days before the procedure. During the procedure, heart rate and intra-arterial blood pressure were continuously monitored. Under local anesthesia, CS was performed via transfemoral approach via a 9 French (Fr) long arterial sheath. Heparin was given intravenously, beginning with a bolus of 4,000 or 5,000 IU, to maintain an activated clotting time 250s ~ 350s. We did not routinely place a transvenous pacemaker or treat patients with atropine prior to the procedure. After diagnostic angiography, 9 Fr guiding catheter (Britetip, Cordis Corporation, Miami, FL, USA) was inserted to common carotid artery just proximal to the lesion by use of coaxial catheterization techniques with 6 Fr catheter (JB2, Cathex Co., Ltd.) and 0.035-inch guidewire (Radifocus, Terumo CO). The length and width of the lesion were measured angiographically by inserting INTERSLUE measure wire (Clinical Supply CO., Ltd.) into external carotid artery so that the suitable balloon and stent would be selected. A 0.014 inch, 300 cm microguidewire (Choice PT, Boston Scientific CO) was used to cross the lesion and predilation was performed using a percutaneous transluminal angioplasty (PTA) balloon (Savvy, Cordis Europa, N.V., Roden, The Nethelands) that was advanced over the wire and positioned at the stenosis. Thereafter, self-expandable stent was deployed to the lesion. In seven patients, SMART biliary stents (Cordis Corporation) were used and in one patient, Easywall stent (Boston Scientific) was used. At postdilation, distal protection balloon (Naviballoon, Kaneka MEDIX CO) was used to prevent distal embolism from stent strut. While distal protection balloon was inflated, postdilation was performed by using PTA balloon such as Powerflex (Cordis Europa) or OPTA (Cordis Europa) and the debris was aspirated from the guiding catheter. After that, intravascular ultrasonography was performed to evaluate the fitness of the stent, if possible. In patients with hypotention or bradycardia associated with the procedure, intravenous atropine was given if necessary.

As a follow-up protocol, every patient underwent angiography 6 months later. Thereafter, they were evaluated by a neurologist every 6 months and underwent carotid duplex ultrasound.

Results

With CS, the technical success rate was 77.5% (7/8). In one patient (case 5) with dense calcification around the common carotid artery, 45% stenosis was left. Mean angiographic stenosis (± standard deviation) was reduced from 77.6% (± 10.4) to 14.5% (± 14.7).

Of the 8 CS procedures, there were 2 minor strokes (25%). In one patient (case 2), the distal protection balloon ruptured and migrated to precentral artery, resulting in cerebral infarction with motor aphasia (figure 1). One patient (case 4) revealed right hemiparesis on the way

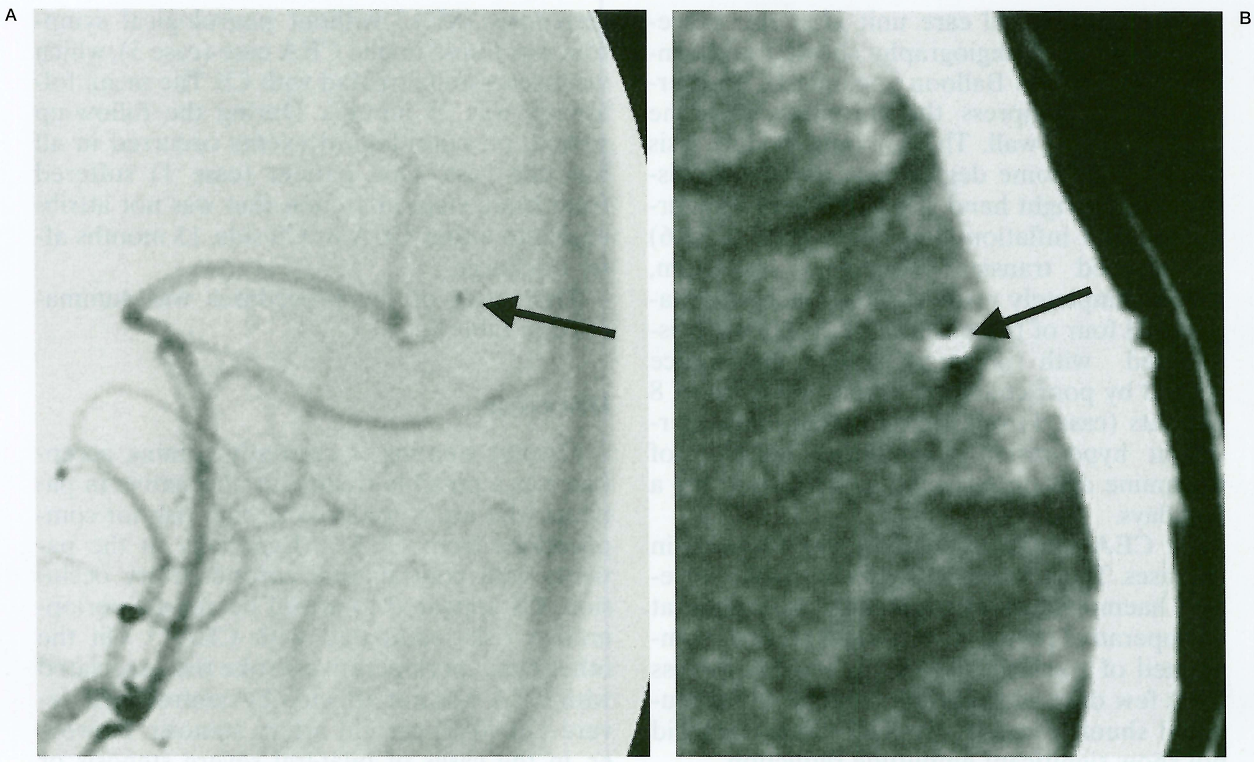

Figure 1 A) Angiography of the patient (case 2) in whom protective balloon ruptured during the post-dilation. The fragment of the ruptured balloon (arrow) was migrated into left precentral artery. B) The fragment of the balloon was visualized as a high density spot (arrow) in the left frontal lobe in the computed tomographic scan.

Table 1

Case	Age	Sex	Presentation	Symptomatic side	% stenosis	Medical risk	Angio risk	Other radiological findings
1	78	male	minor stroke	right	rt. 99/lt. 75	HTN, AP	lt. siphon stenosis	rt. CBF mild reduction
2	63	male	TIA	right	rt. 95/lt. 84	HTN	lt. high position	
3	71	male	amaurosis	left	rt. 87/lt. 85	HTN, hypothyroidism		rt. dense calcification
4	64	male	TIA	right	rt. 95/lt. 70	HTN		bil. soft plaque
5	63	male	minor stroke	right	rt. 85/lt. 71	diabetic nephropathy, HTN, ASO		rt. CBF mild reduction
6	66	male	minor stroke	left	rt. 90/lt. 95	HTN, ASO, DM	lt. M1 stenosis	lt. CBF severe reduction
7	69	male	minor stroke	left	rt. 85/lt. 84	HTN, ASO, DM	lt. VAO, bil siphon stenosis	bil. CBF severe reduction
8	68	male	asymptomatic	none	rt. 88/lt. 70			

TIA: transient ischemic attack, HTN: hypertension, AP: angina pectoris, ASO: arteriosclerotic obliteration, DM: diabetes mellitus, VAO: vertebral artery occlusion, CBF: cerebral blood flow to the neurological care unit after the procedure. Emergent angiography showed acute instent thrombosis. Balloon angioplasty was performed to compress the thrombus into the carotid artery wall. Though right hemiparesis improved at some degree, fine movement disturbance of right hand was left (figure 2). During balloon inflation, 4 patients (case 1,2,5,6) experienced transient neurologic symptom, which completely resolved after balloon deflation. All four of these transient events were associated with haemodynamic intolerance caused by poor collateral blood flow. One of 8 patients (case 1) revealed postprocedural persistent hypotension. Continuous infusion of dopamine and dobutamine was required for a few days.

At CEA, sufficient dilation was obtained in all cases. There were no ischemic stroke, cerebral haemorrhage, or myocardial infarction at perioperative period. One patient (case 5) complained of transient dysphagia and hoarseness for a few days. No procedure required intraluminal shunt, because any SEP monitoring did not show significant amplitude reduction.

In this series, mean interval between CS and CEA was 19.8 ± 5.3 days (range, 14-29 days). At 6-month follow-up angiography, significant restenosis (85%) without neurological symptom was found in one CEA case (case 3), which was successfully treated with CS. The mean follow-up was 25 months. During the follow-up period, no neurological events occurred in all but one case. One patient (case 1) suffered from brain stem infarction that was not attributable to either CEA or CS side, 13 months after discharge.

The result of the procedures was summarized at table 2.

Discussion

Carotid stenting is currently gaining acceptance as a possible treatment alternative in patients who are considered at high risk for complications from CEA [5-7]. Especially in the patients with contralateral carotid artery occlusion, CS appeared to afford decreased perioperative risks compared with CEA [8,9]. On the other hand, perioperative stroke risk associated with CEA was not affected by contralateral severe (70-90%) carotid artery stenosis. However, in the cases of bilateral severe stenosis or unilateral stenosis with contralateral occlusion, unilateral carotid revascularization can increase contralateral cerebral blood flow [10], and

Table 2

Case	Age	Sex	Complication at CS	Torelance for balloon occlusion	Other events at CS	Complication at CEA	Intraluminal shunt	Lower cranial nerve palsy	Other events at CEA
1	78	M	none	(-)	persistent hypotension	none	unnecessary	none	
2	63	M	minor stroke	(-)		none	unnecessary	none	
3	71	M	none	(+)		none	unnecessary	none	restenosis
4	64	M	minor stroke	(+)		none	unnecessary	none	
5	63	M	none	(-)		none	unnecessary	transient	
6	66	M	none	(-)		none	unnecessary	none	
7	69	M	none	(+)		none	unnecessary	none	
8	68	M	none	(+)		none	unnecessary	none	

CS: carotid stenting, CEA: carotid endarterectomy angiographically identified collaterals are associated with a lower risk of perioperative stroke of CEA [11]. Therefore, we assumed that there was a subgroup of patients with bilateral severe carotid stenosis who may benefit from preceding revascularization of contralateral carotid artery by reducing the stroke risk at the following CEA.

In this series, two minor strokes were documented at the initial CS. Although less invasive, CS is not optimal for all subgroups of carotid artery stenosis. Like CEA, there was a high-risk group for CS such as the cases with echolucent soft plaque, kink lesion, or surrounding dense calcification. In case 4 with cerebral infarction was caused by distal emboli from instent thrombosis, resulting from insufficient dilation by intolerance during postdilation and the presence of calcification. In the case of intolerance at the pre- or postdilation at the CS, duration of balloon occlusion should be as short as possible especially in the presence of contralateral severe stenosis or occlusion. This may result in insufficient dilation at the CS. The proper use of brain protection at the pre- or post-dilation at the CS may solve this problem especially in the case of bilateral severe carotid stenosis.

Although subsequent CEAs were performed safely and intraluminal shunt was not introduced in any cases, no cases showed clear benefit from the previous contralateral revascularization. In the cases with impaired vascular reserve at the CEA side in the CBF study before CS (case 1,5,6,7), CBF might be affected by improved collateral blood flow provided by contralateral CS. However, in the cases with normal CBF, theoretically, the safety of the CEA would not be affected by the former CS. This speculation remains to be tested by examining the relationship between the CBF at the CEA side after the CS for the contralateral side and the peri-procedural risk of CEA.

The order of CS for asymptomatic side and CEA for symptomatic side is not indicated for the neurologically unstable symptomatic cases such as crescendo transient ischemic attack (TIA). At any rate, our preliminary data showed that our staged CS and CEA strategy cannot be blindly applied to all bilateral carotid artery stenosis. There are various conditions in each patient as to plaque morphology, CBF, neurological stability, and so on.

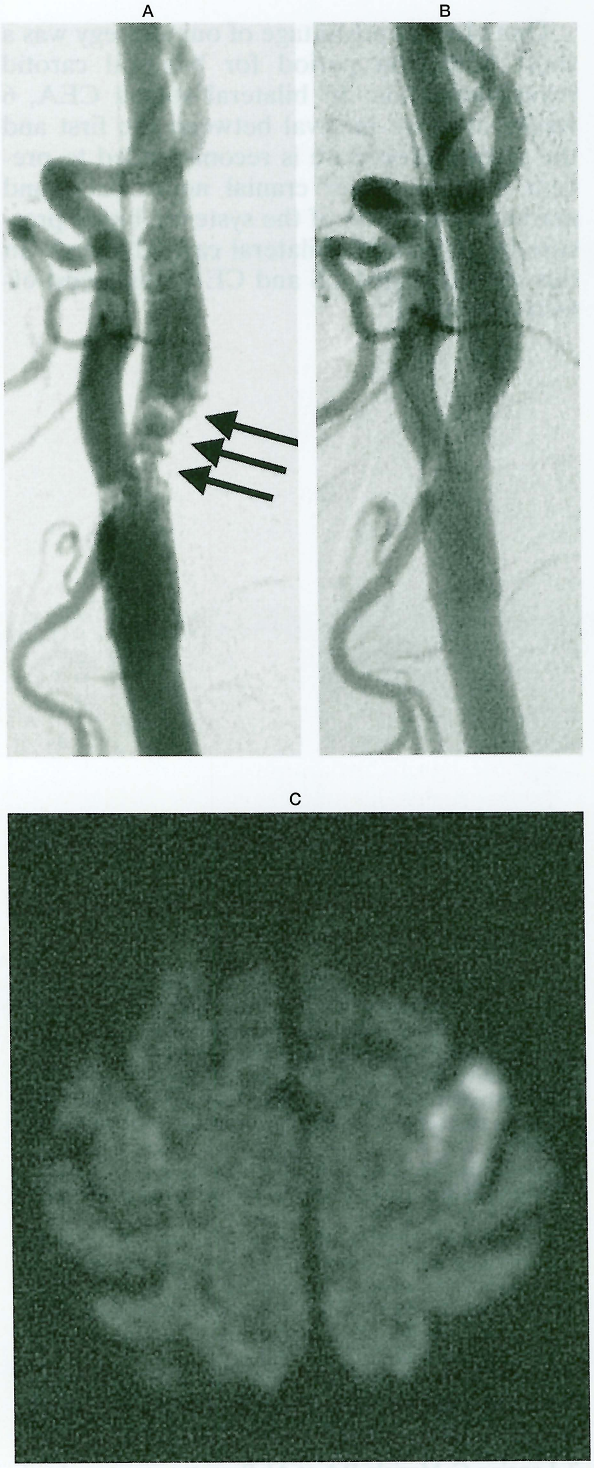

Figure 2 A) Emergent angiography of the patient (case 4) who revealed right hemiparesis on the way to neurological care unit after left carotid stenting. In-stent thrombi (arrows) were visualized as defect of contrast media. B) Angiography after emergent PTA. In-stent thrombi disappeared. C) Diffusion Weighted Image immediately after the series of the procedures. Cerebral infarction was found in the left frontal lobe.

One obvious advantage of our strategy was a short admission period for bilateral carotid revascularization. In bilateral staged CEA, 6 weeks or more interval between the first and the second procedure is recommended to prevent bilateral lower cranial nerve palsy and marked fluctuation of the systemic blood pressure by stimulating bilateral carotid sinus [12]. In this aspect, staged CS and CEA was a cost-effective method.

Conclusions

In our staged CS and CEA strategy, subsequent CEA could be safely performed probably owing to contralateral preceding CS. However, the high complication rate of CS for the asymptomatic side was not acceptable. If the result of CS is improved, staged CS and CEA strategy will be applicable as one of the options to treat bilateral carotid artery stenosis.

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